

Intel® Quark™ Microcontroller Software Interface (Intel® QMSI)

Malcolm Prinn,

October 2016

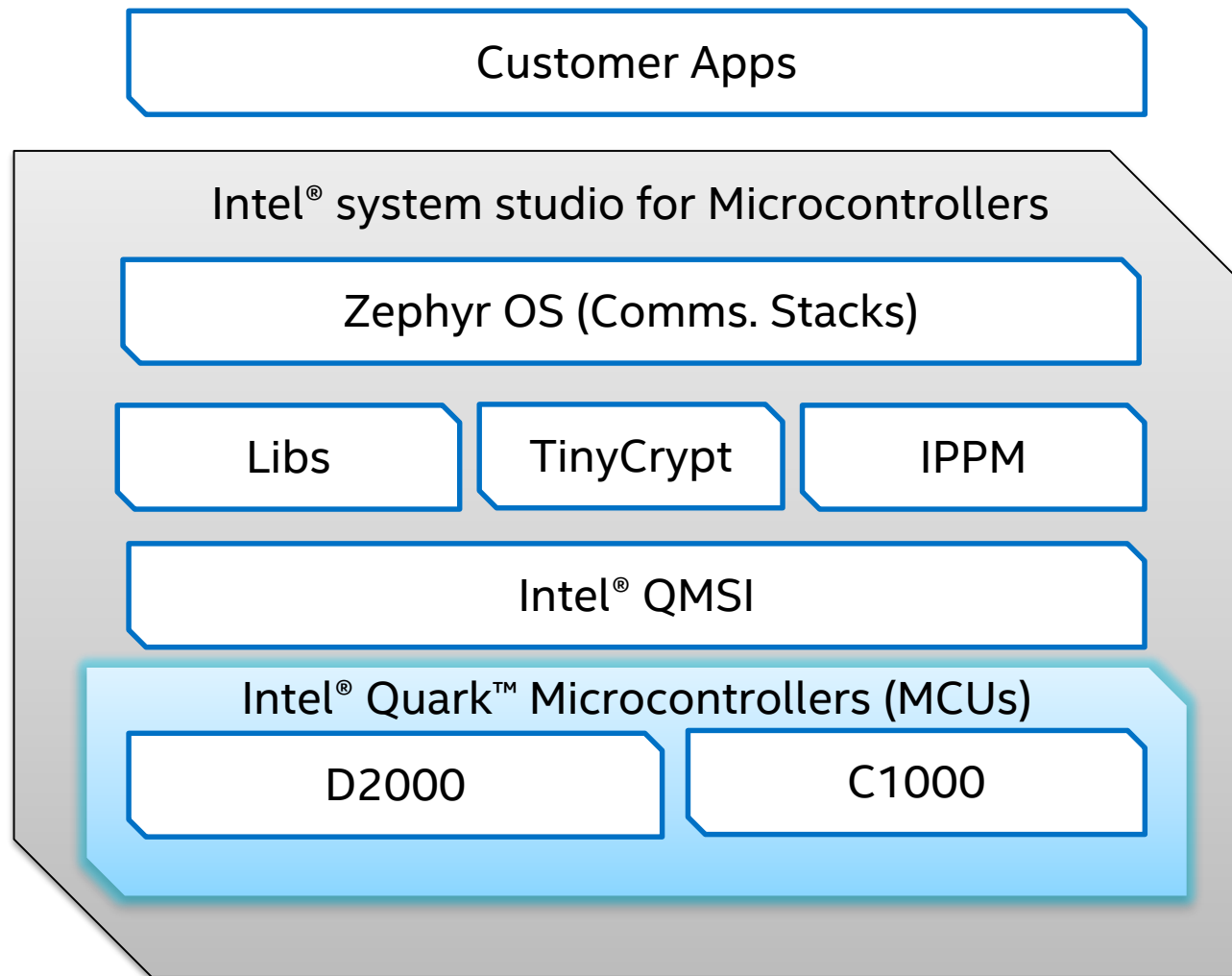
Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.

Intel® QMSI quick facts

- Hardware Abstraction Layer written in C
- ~100k LoC
- Supports most Intel® Quark™ MCU SoCs
- Small code size / stack usage
- Low power functionality



Intel® Quark™ MCU family

The new Intel® Quark™ microcontroller D1000, Intel® Quark™ microcontroller D2000, and Intel® Quark™ SE microcontroller C1000 for IoT extend Intel's product roadmap to the very edge of the Internet of Things (IoT), enabling a consistent architecture from things to the cloud, with a broad portfolio of Intel products spanning from Intel® Quark™ to Intel® Xeon® processors.



Low Power

Optimized for low power consumption, such as battery-powered applications



Integrated Security

With manageability and connectivity to help protect your data at every endpoint



Scalable Architecture

Maximize investment by reusing software to scale up and down to any Intel processor

Optimization Notice

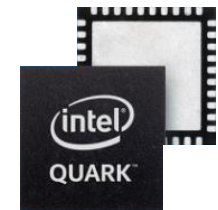
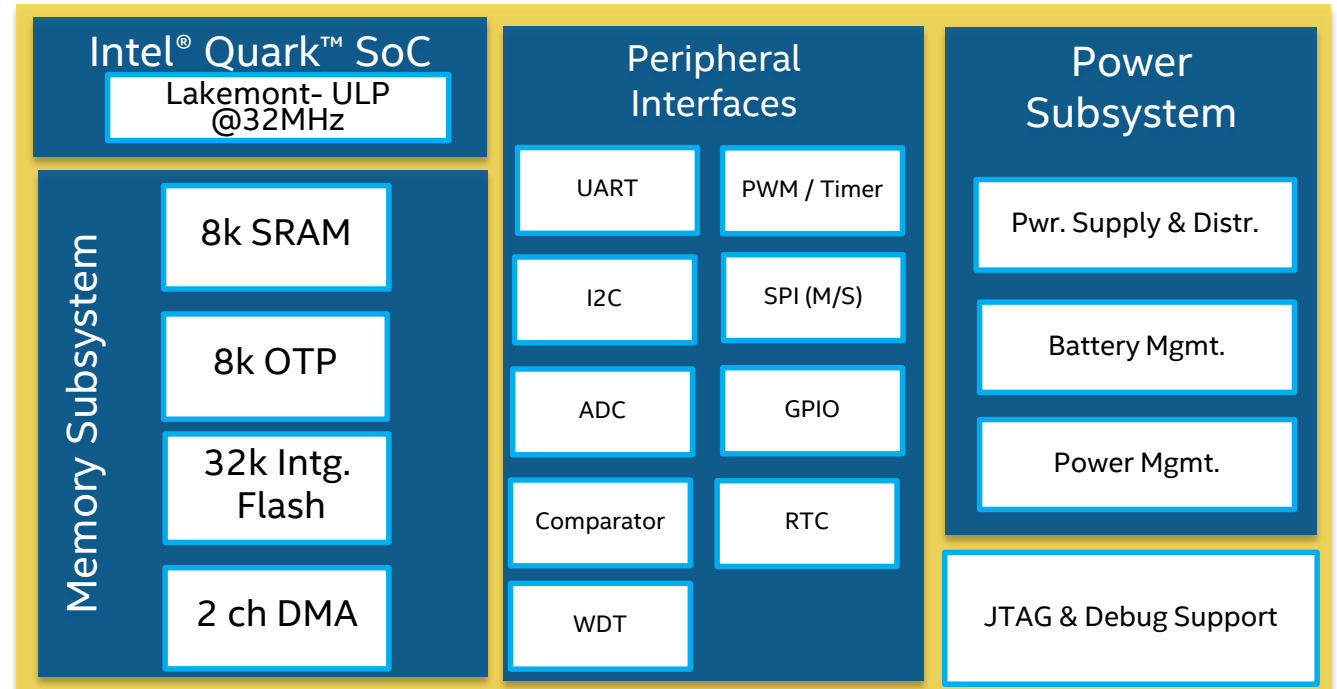
Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



INTEL® QUARK™ MICROCONTROLLER D2000

- Ultra low power, Entry Level
- 32MHz, 32-bit x86 Microcontroller, 32kB Flash, 8kB SRAM
- Scalable Software Development Kit, with sample apps and libraries
- Pre-validated comms and sensor modules
- Full Intel® x86 instruction set architecture for compatibility and scalability

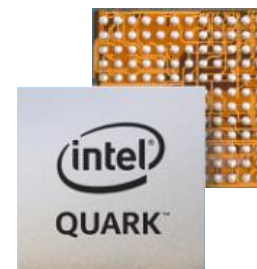
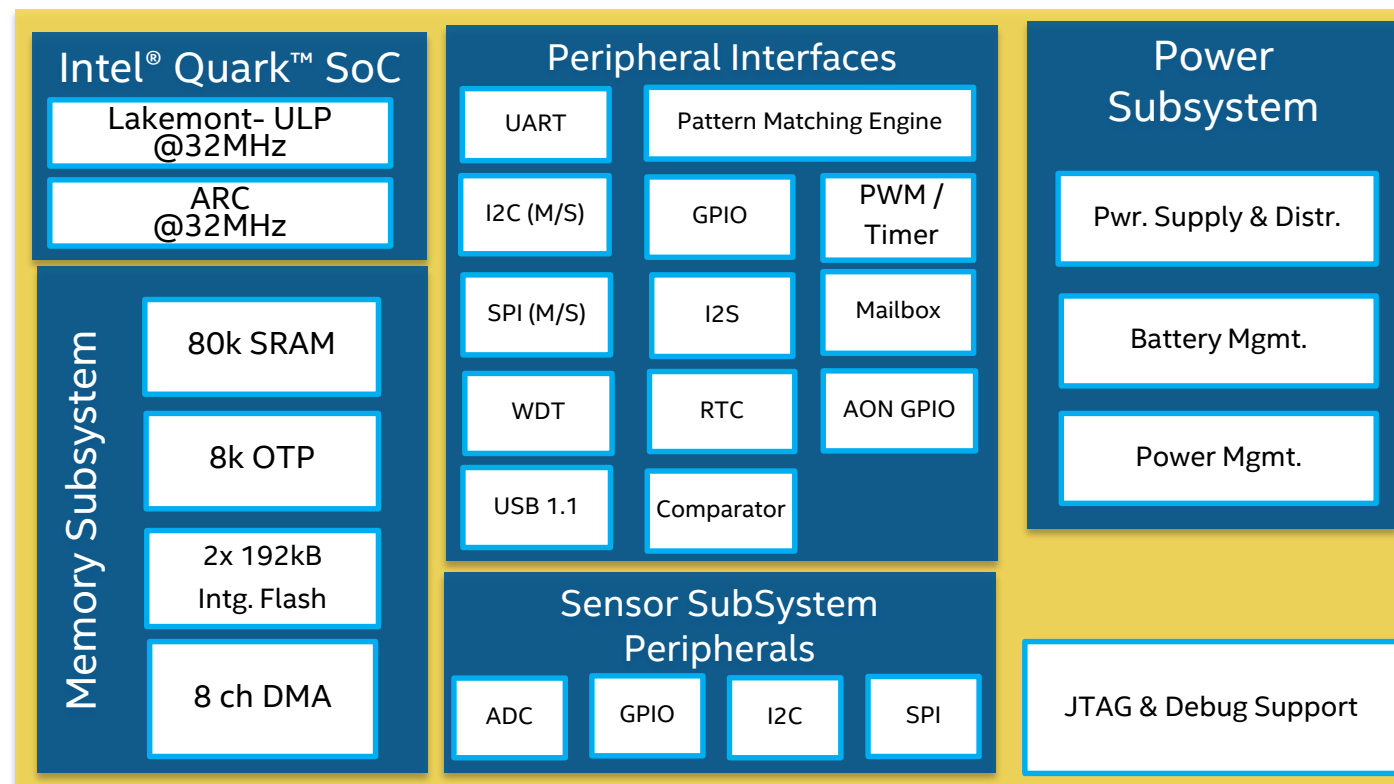


Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

INTEL® QUARK™ SE MICROCONTROLLER C1000

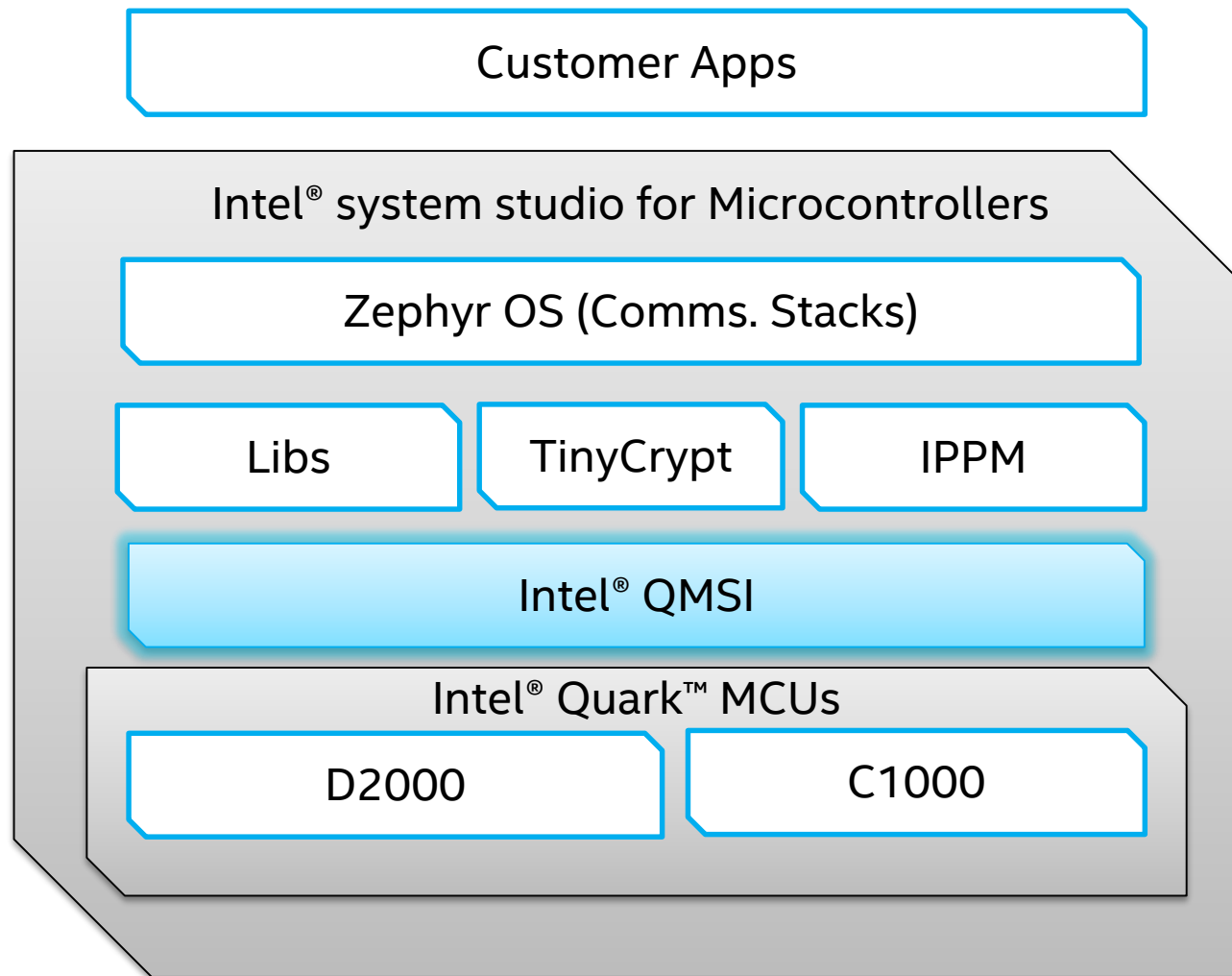
- High-efficiency power consumption
- 32MHz, 32-bit x86 Microcontroller
- 384Kb Flash, 80kB SRAM
- Scalable Software Development Kit, with sample apps and libraries
- Pre-validated comms and sensor modules
- Full Intel® x86 instruction set architecture for compatibility and scalability
- Always sensing: always-listening Internal Sensor Hub
- Intelligent: Pattern Matching Engine



Optimization Notice

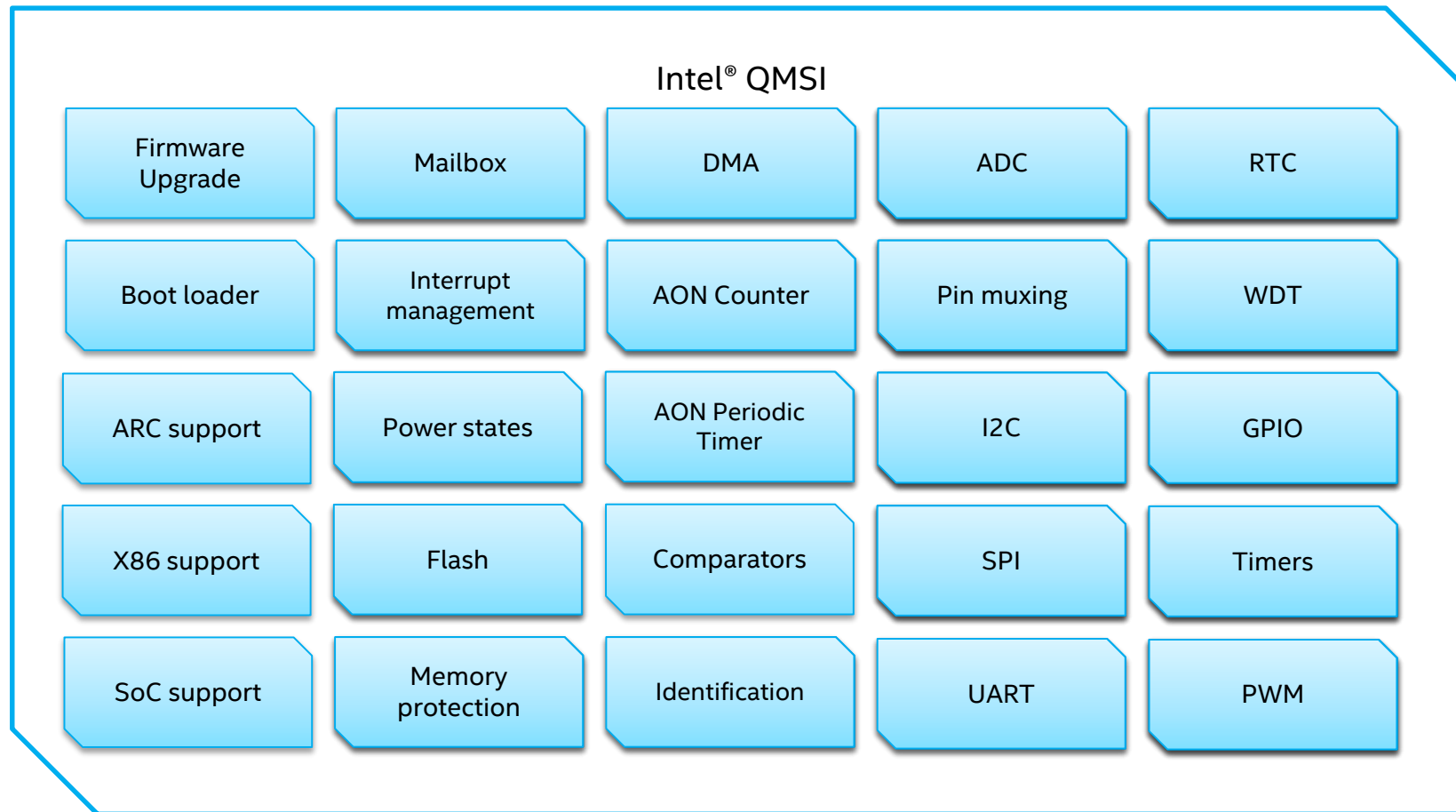
Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



Intel® Quark™ Microcontroller Software Interface

- Intel® Quark™ Microcontrollers Hardware Abstraction Layer (HAL)
- APIs provide a standard interface to all functionality in Intel® Quark™ microcontrollers.
- APIs are consistent across the Intel® Quark™ microcontroller family of devices.
- Included with this API are a collection of sample applications to enable users to get started quickly.
- Embedded devices with a limited amount of memory,
 - Object code size & stack size minimization is a primary design objective.
 - Everything accessed as MMIO.
 - Nothing is dynamic, all the heavy work is done at compile time.
 - Garbage collection on unused functionality.



Optimization Notice

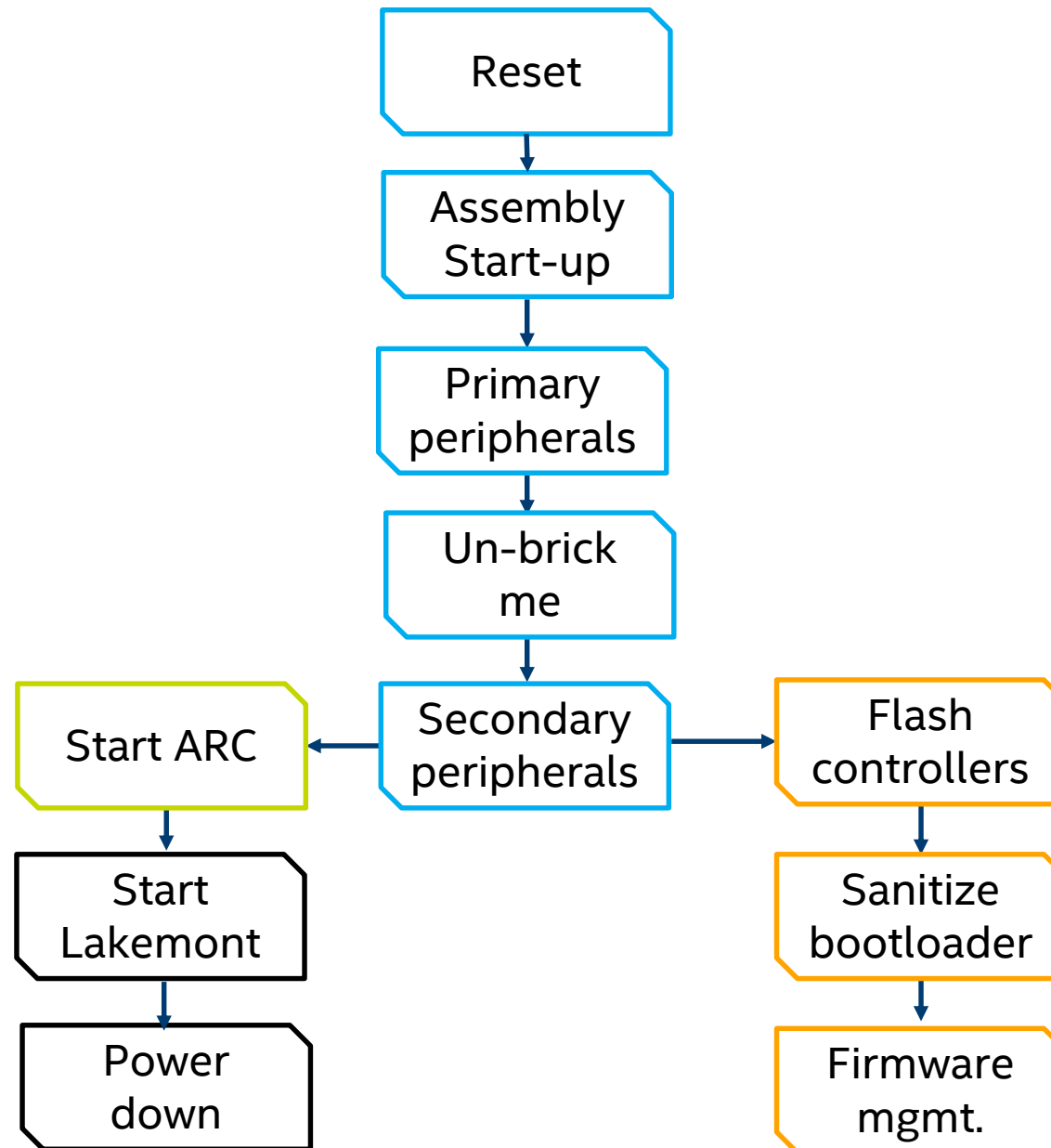
Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.

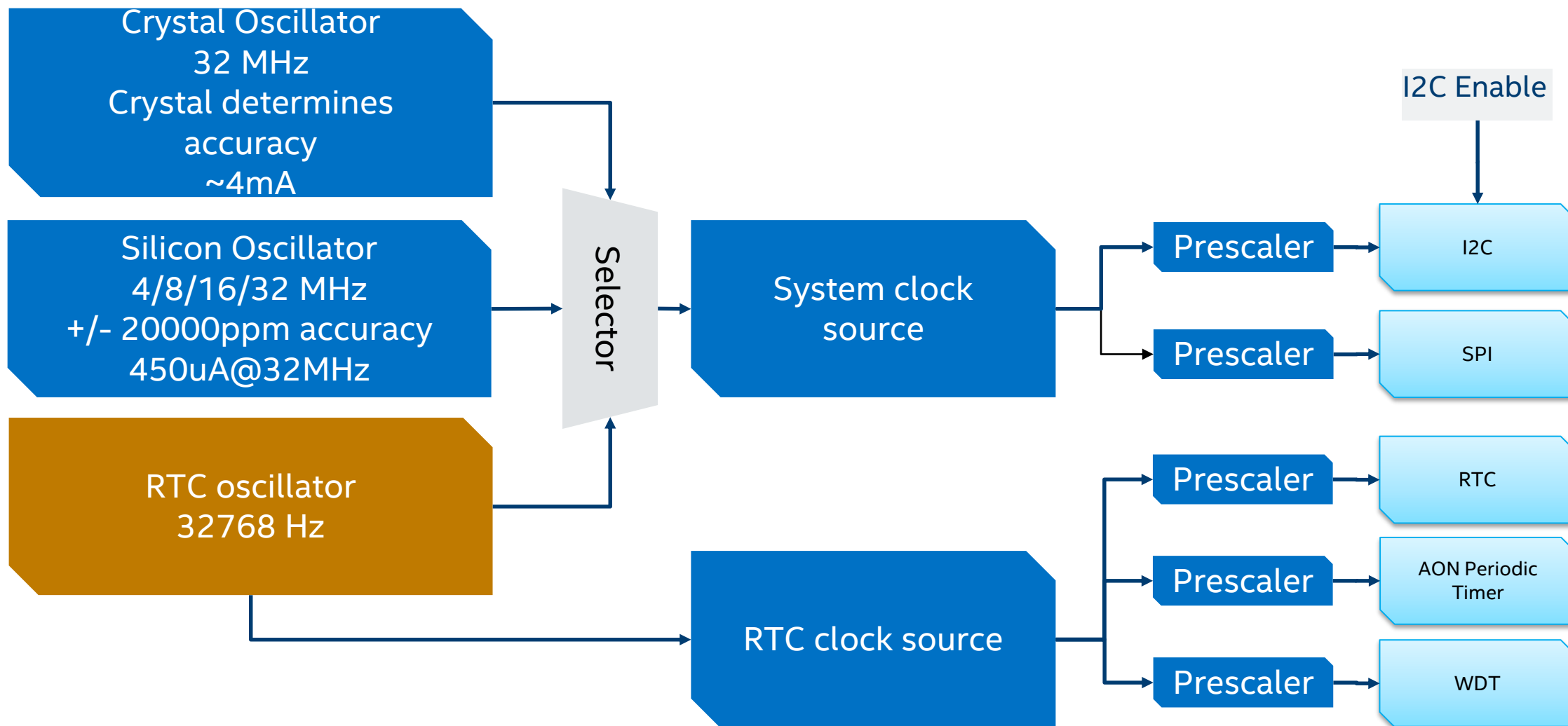
Bootloader / ROM

- Bootstrap
- TRIM code calculation
- Firmware update management
 - Host tools also provided (fork of DFU utils)
- Un-brick me

Boot flow



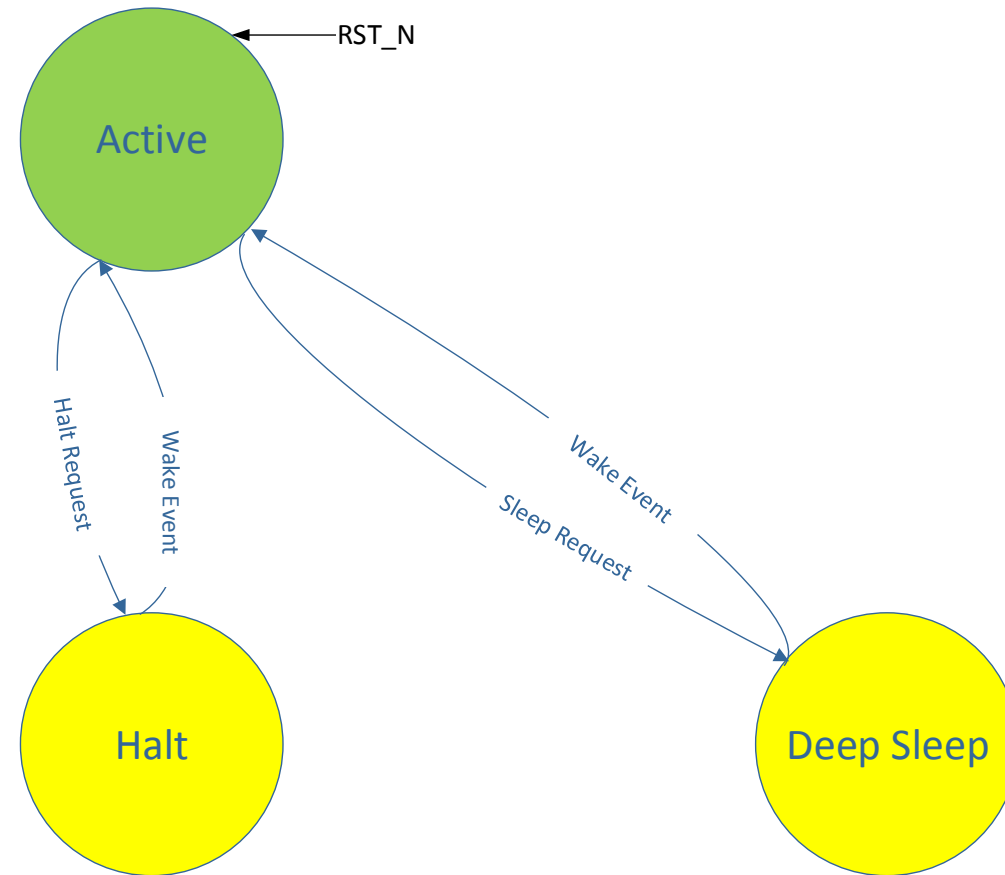
Clocking



Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

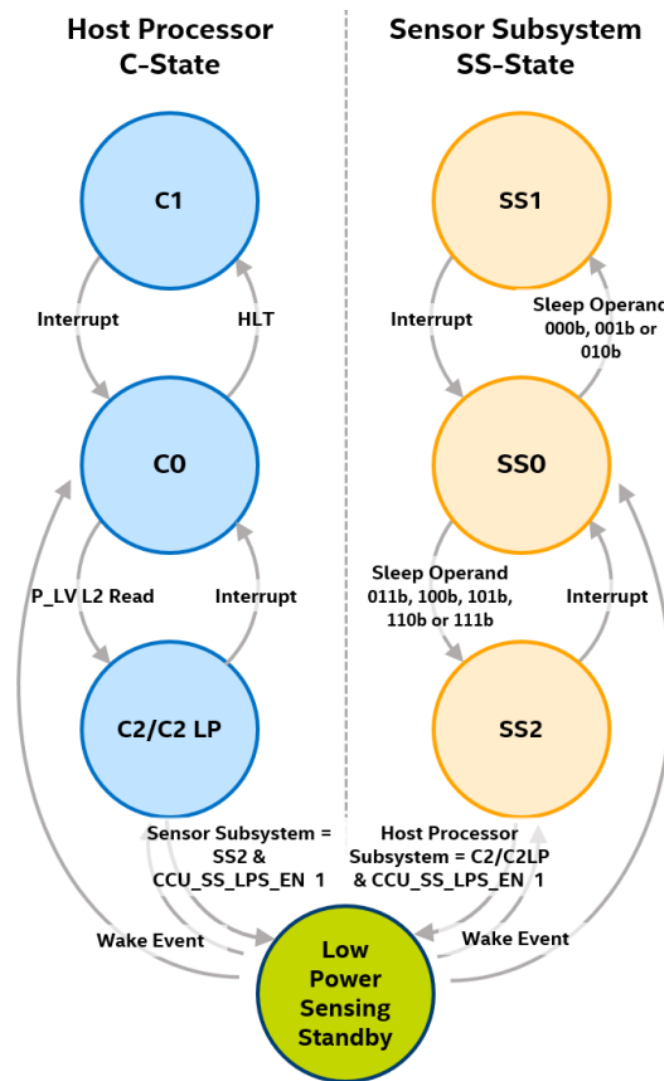
Power states - D2000



Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

Power states - C1000



Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.

Sample Real Time Clock driver usage

```
qm_rtc_config_t cfg;
```

```
/* Configure RTC and request the interrupt. */
```

```
cfg.init_val = 0;
```

```
cfg.alarm_en = true;
```

```
cfg.alarm_val = ALARM_INTERVAL;
```

```
cfg.callback = rtc_example_callback;
```

```
cfg.callback_data = NULL;
```

```
cfg.prescaler = CLK_RTC_DIV_1;
```

```
qm_irq_request(QM_IRQ_RTC_0, qm_rtc_isr_0);
```

```
/* Enable RTC. */
```

```
clk_periph_enable(CLK_PERIPH_RTC_REGISTER);
```

```
/* RTC actually starts here. */
```

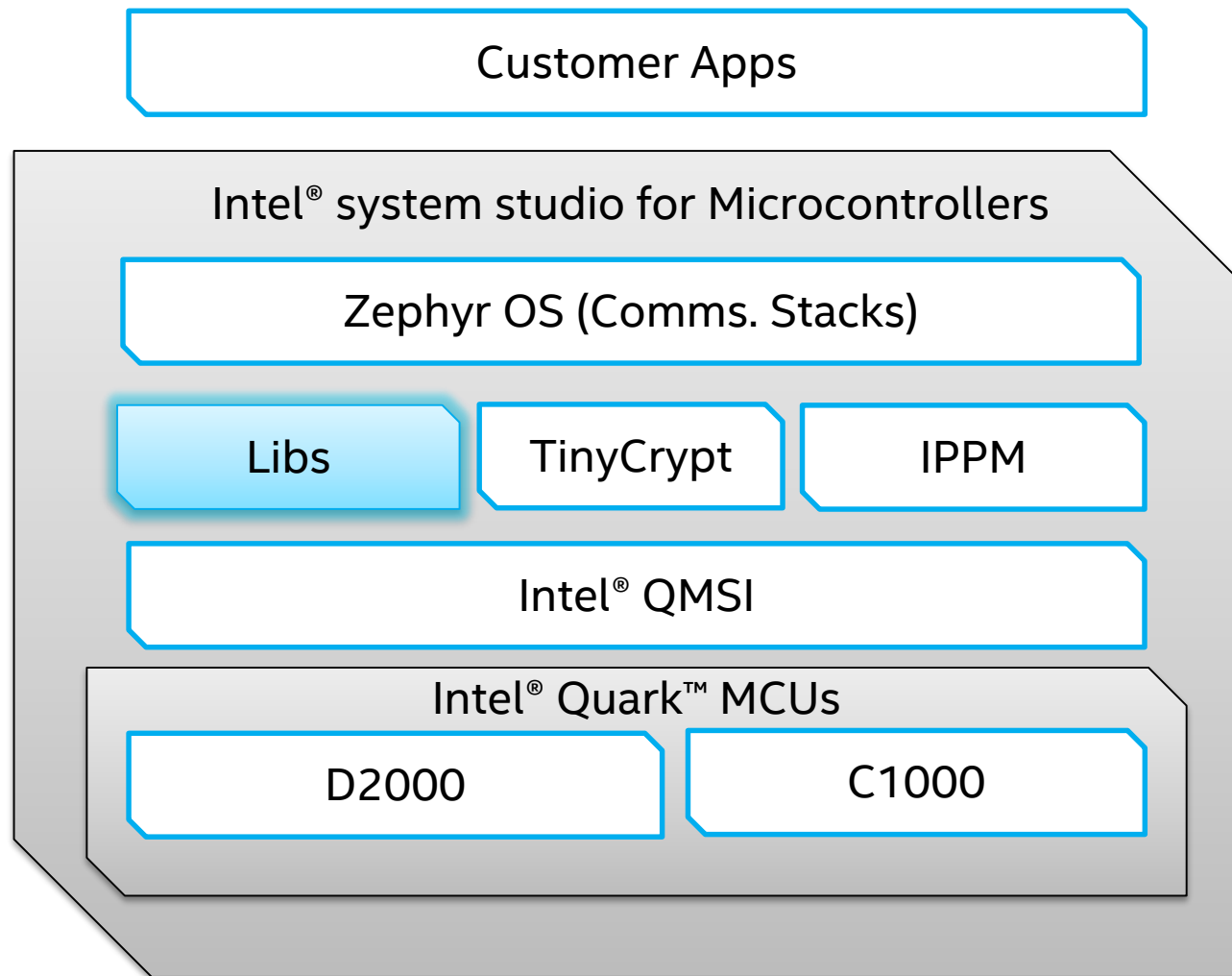
```
qm_rtc_set_config(QM_RTC_0, &cfg);
```

} RTC configuration structure

} Register / request interrupt

} Enable clocking to RTC

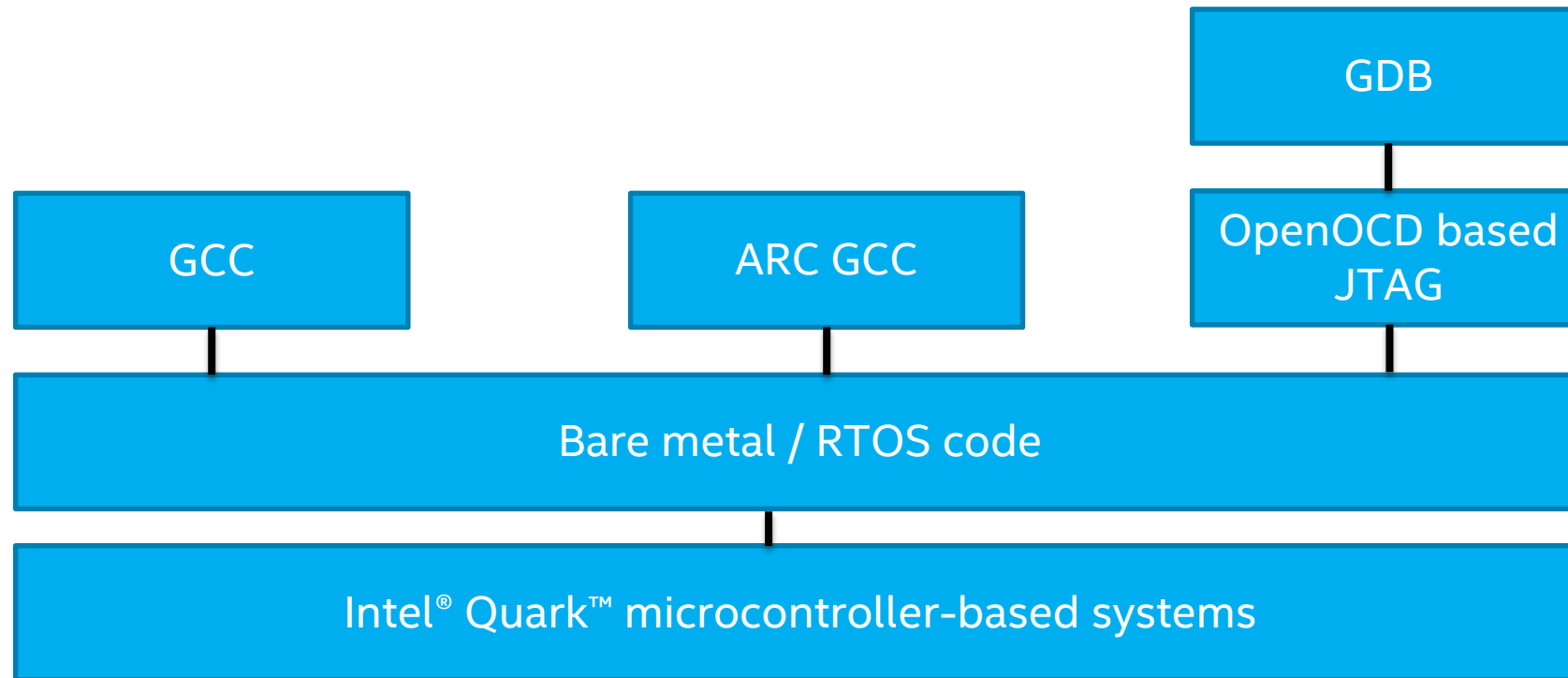
} Set configuration and start RTC



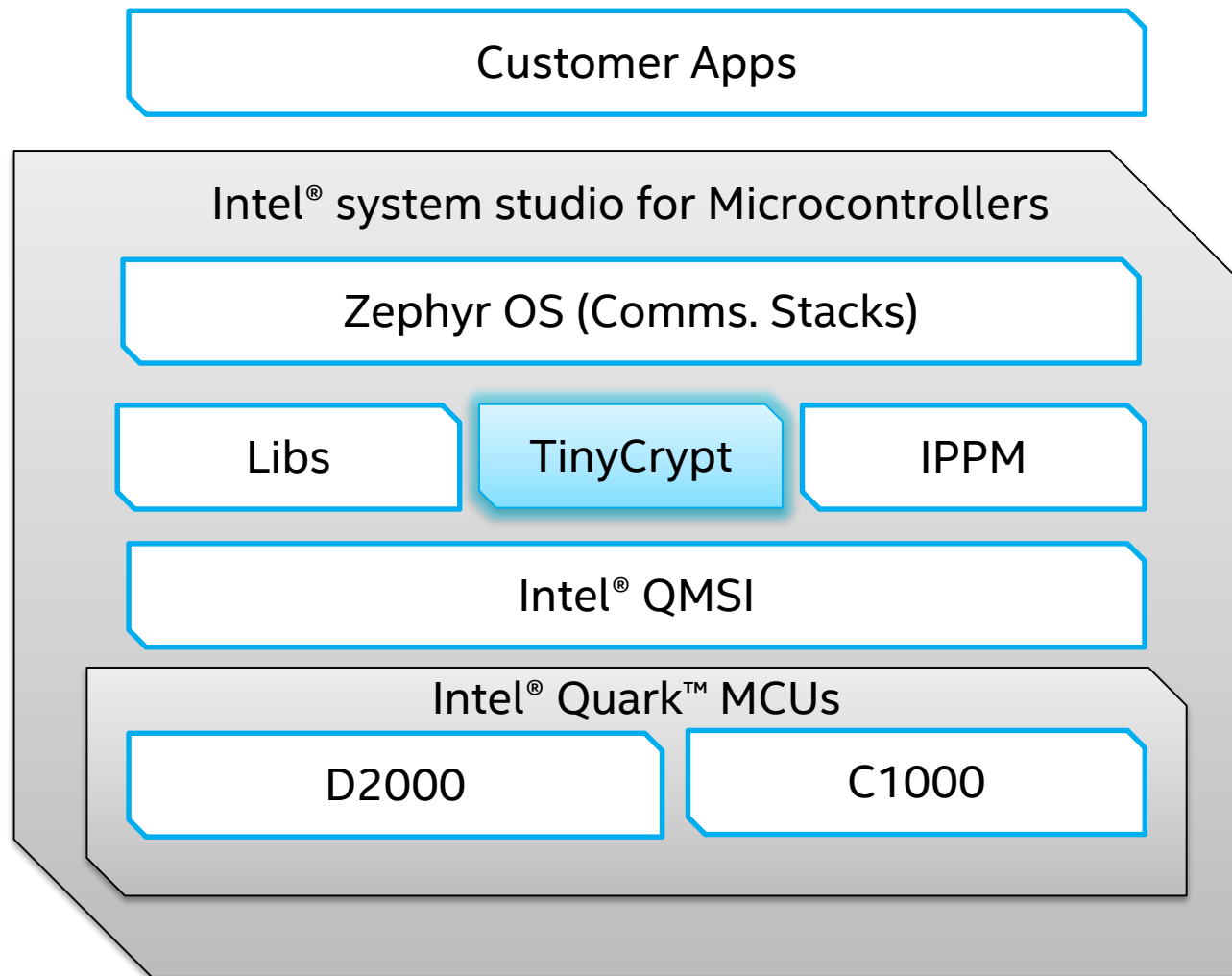
Newlib syscalls

- Pico printf
 - Modular, support for formats can be disabled at compile time
 - Supports 'd', 'u', 'x', 'X' and 's'
- Puts
- Malloc / free
- Assert

Toolchain

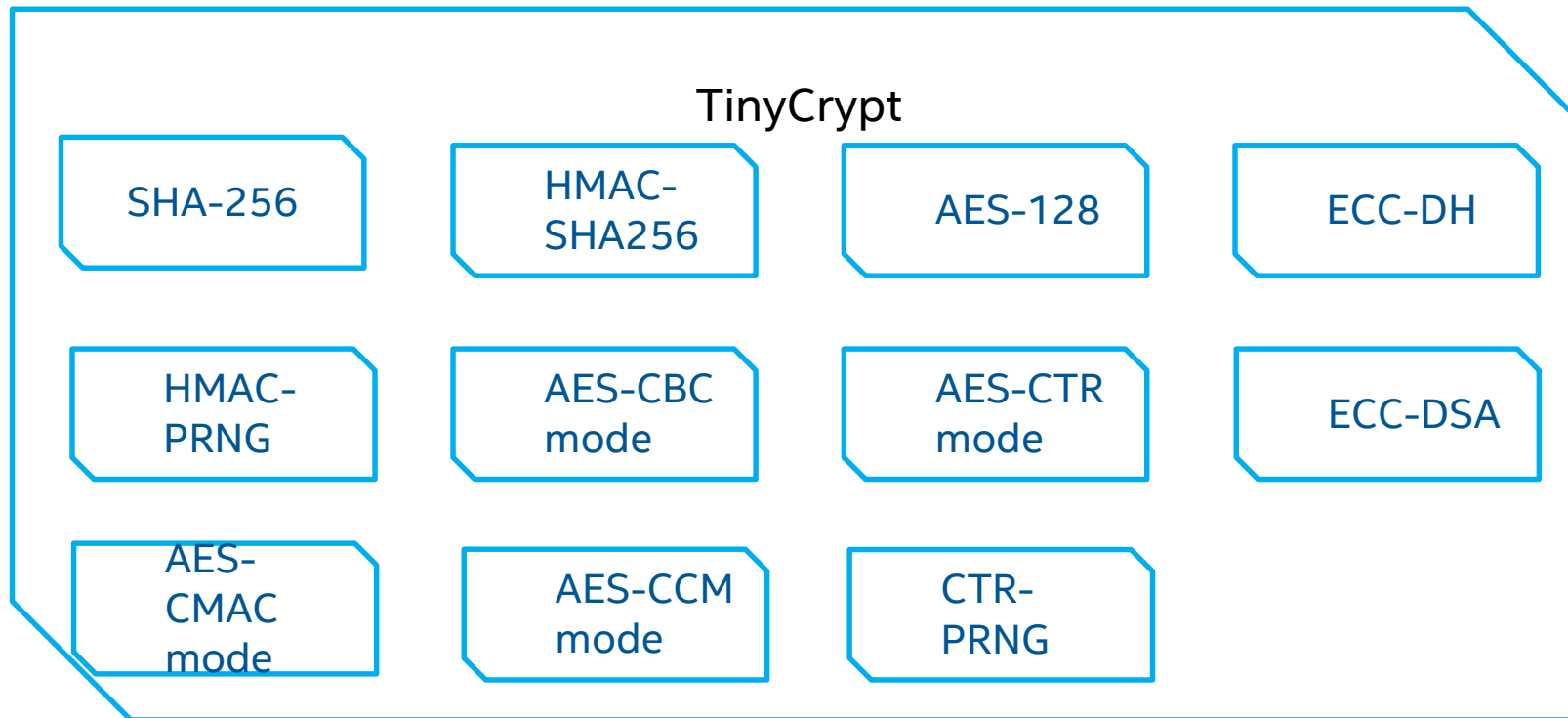


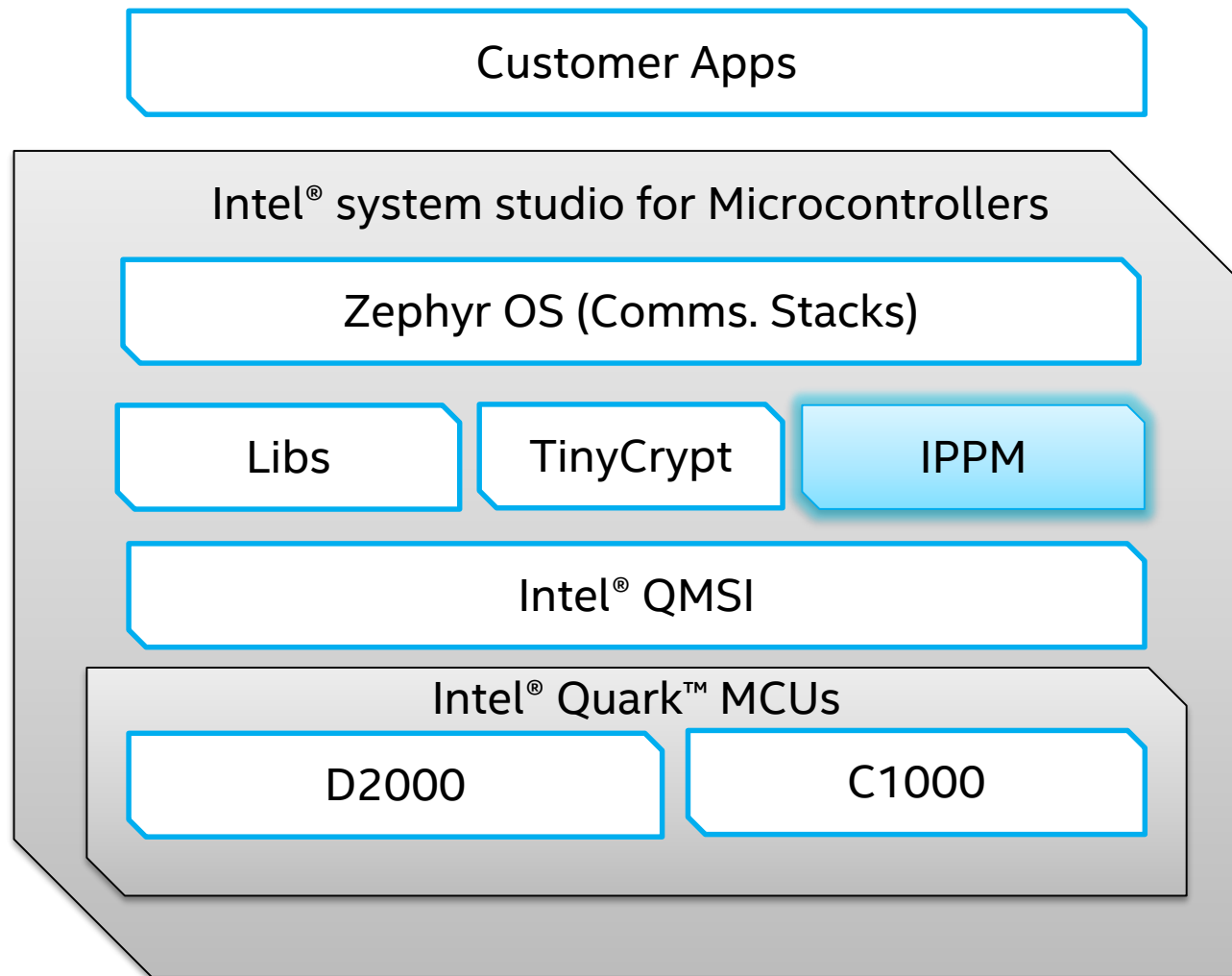
<https://software.intel.com/en-us/articles/issm-toolchain-only-download>



TinyCrypt Library

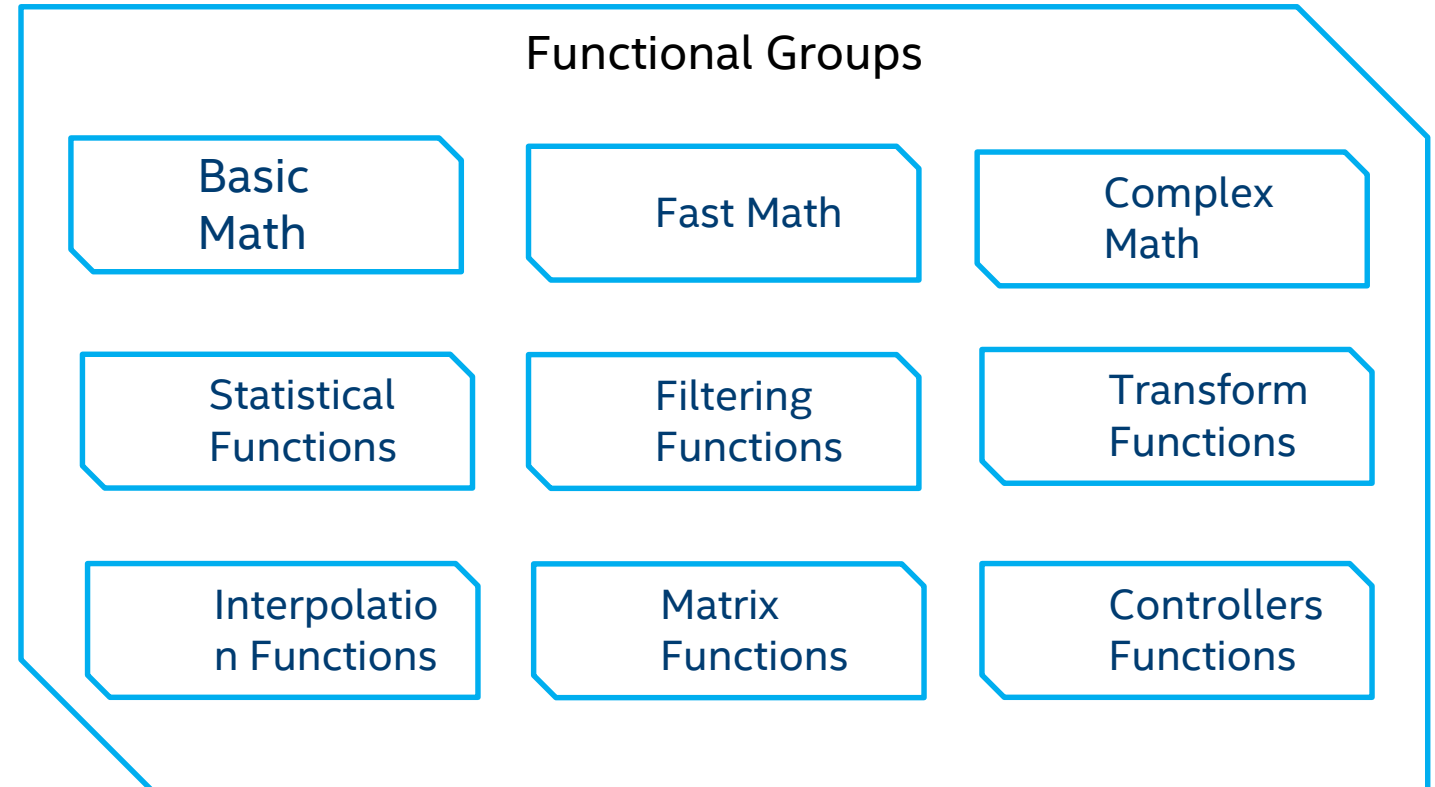
- The TinyCrypt Library provides an implementation for constrained devices of a minimal set of standard cryptography primitives.





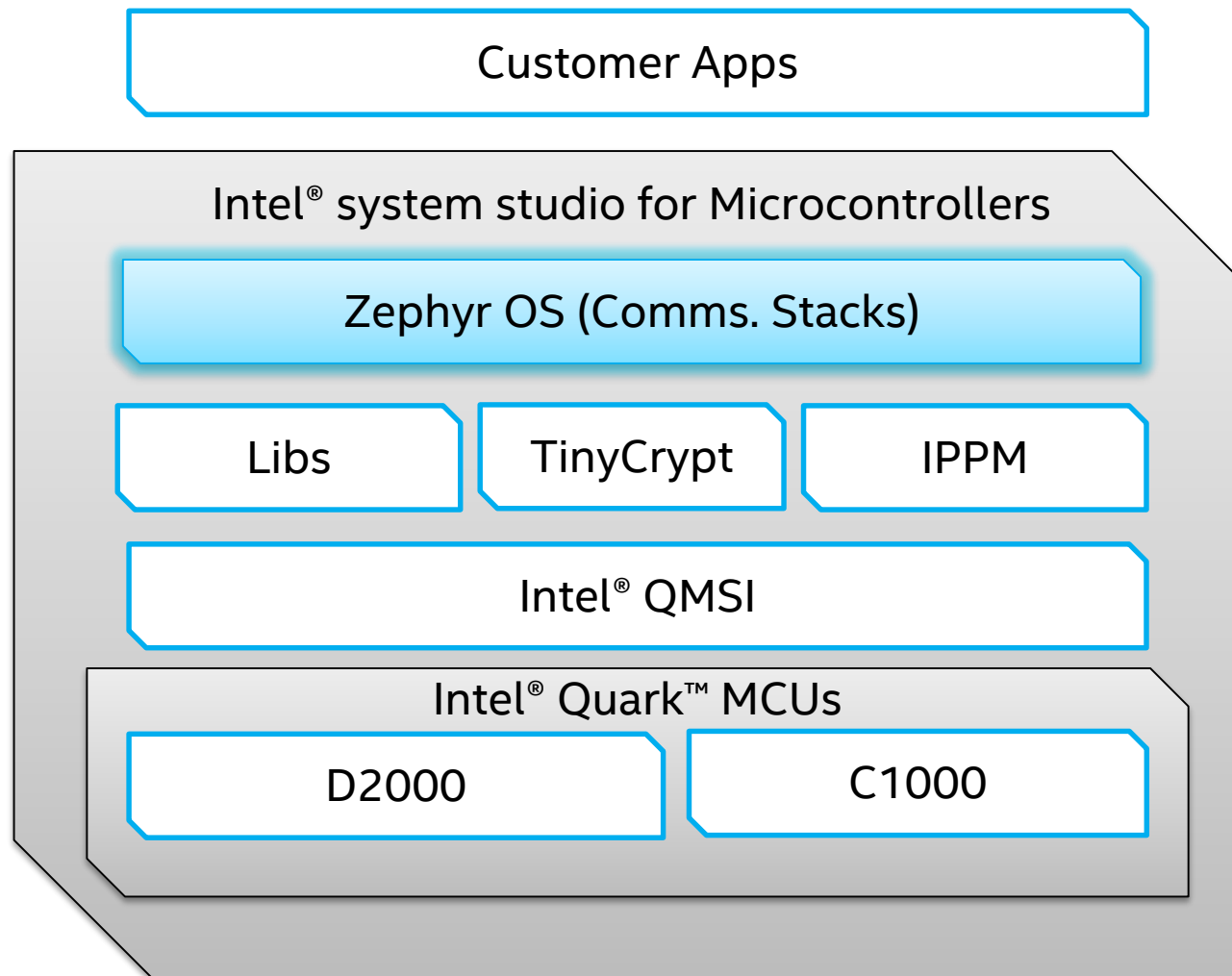
Intel® Performance Primitives for Microcontrollers

- Supported data types
 - Fixed point: q15, q31
 - Floating point: 32f (using floating point simulation)
- Optimization criteria
 - Size (~1 KB per function)
 - Performance
 - Accuracy
 - Power consumption

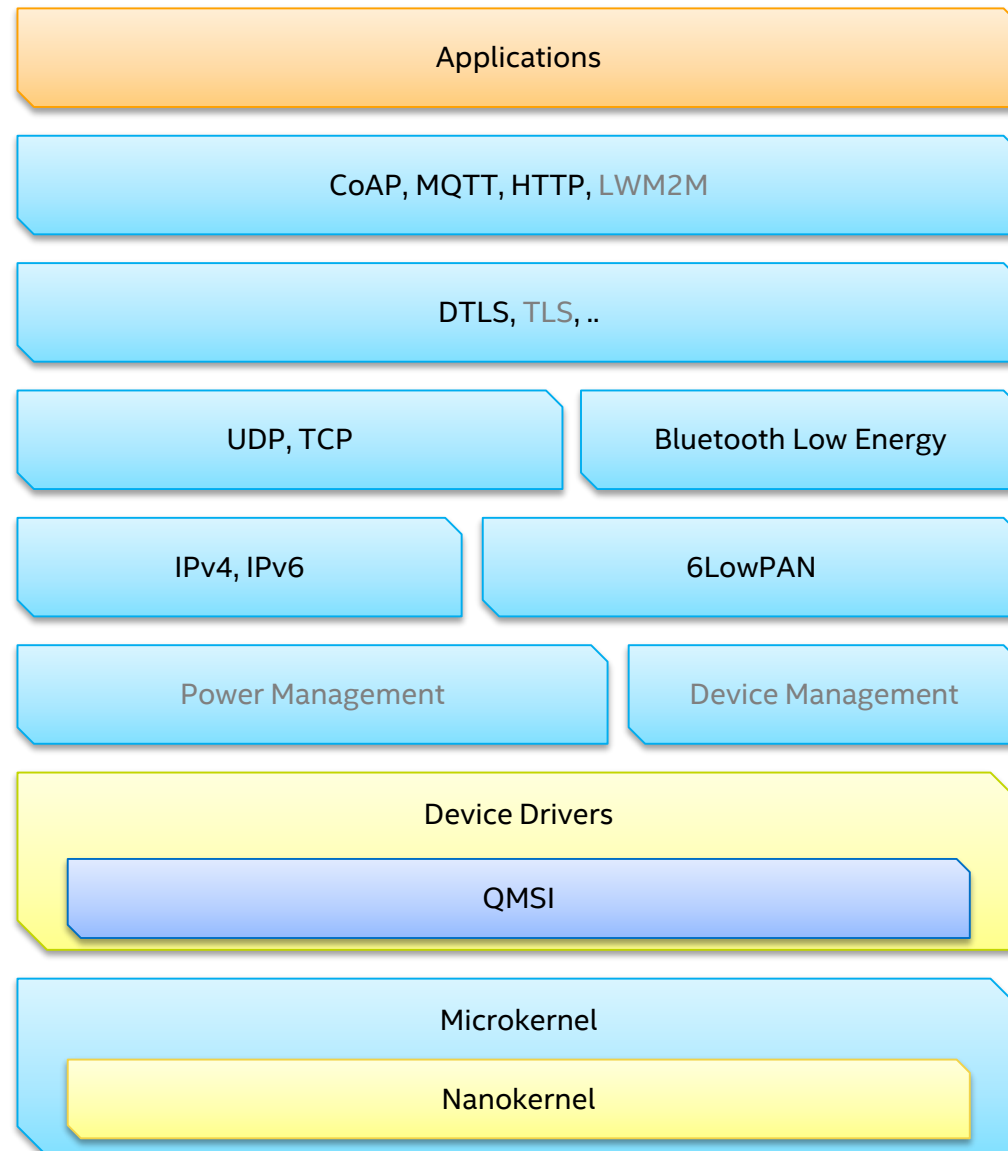


Floating Point Library

- Only applicable to Intel® Quark™ Lakemont processor cores
- Floating Point
 - The Floating Point Library emulates basic floating point operations with hardware integer instructions.
 - Compatible with the Intel® MCU Architecture ; supports Intel® Pentium® processor instruction set minus instructions for x87 floating point unit.
- Fixed point data format
 - Intel® IPP for Microcontrollers functions operate on fixed-point data in Q_n format.
 - Example : X in the Q_{15} format is $X \cdot 2^{-15}$, with the range of supported values for the `lpp16s` data type equal to $[-1, 1 - 2^{-15}]$.



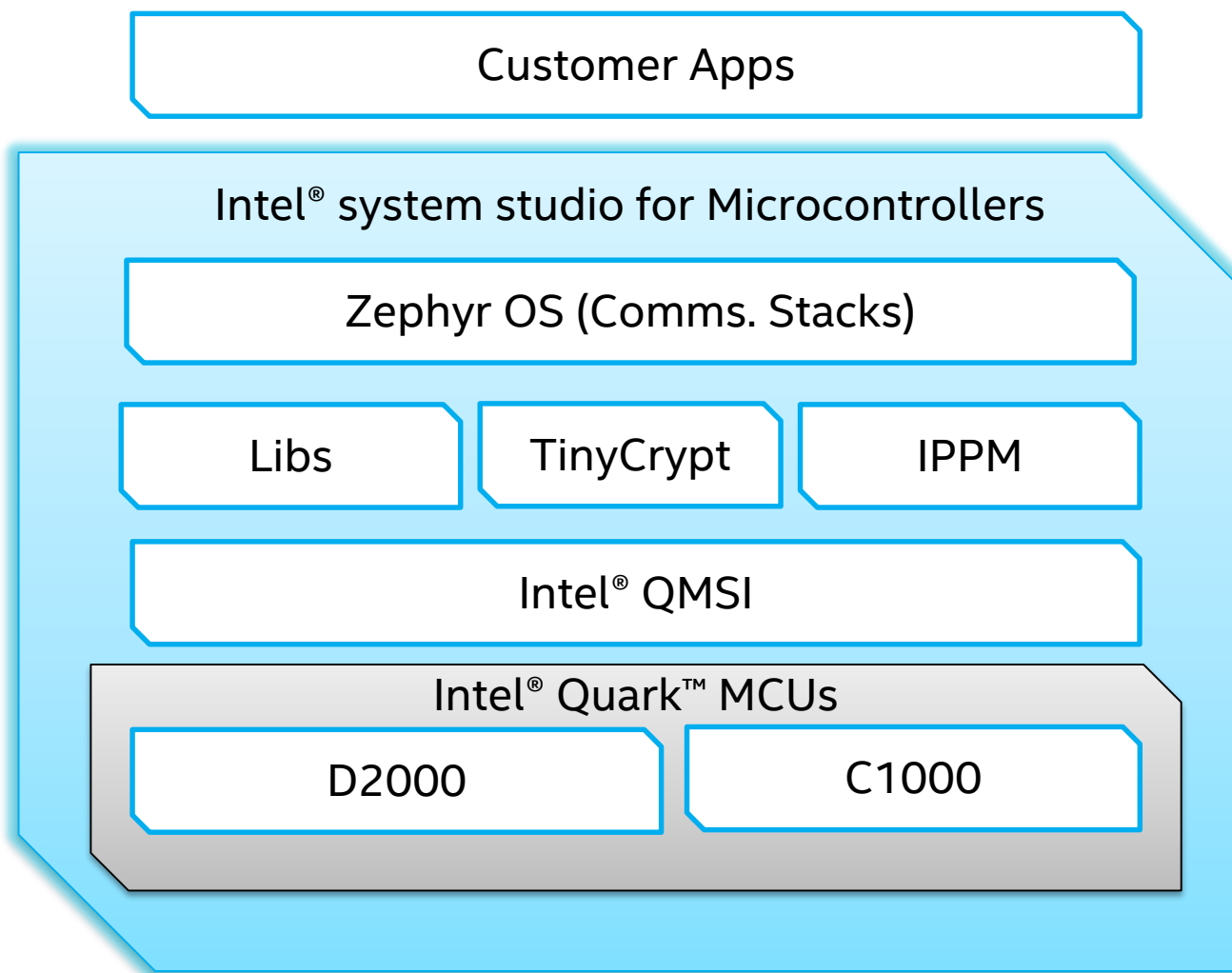
Zephyr



Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



Intel® System Studio for Microcontrollers

- Bundles components into a Software Development Kit (SDK)
- Integrated Development Environment (IDE)
 - Based on Eclipse
- Intel® System Studio for Microcontrollers plugins
- SoC debugger integration
- Windows USB Driver for:
 - Intel® Quark™ Microcontroller D2000 Development Board
 - Intel® Quark™ SE C1000 Development Board

Intel® system studio for Microcontrollers in action

The screenshot displays the Intel System Studio for Microcontrollers interface. The main window is divided into three primary panes:

- Code:** The left pane shows the C source code for `main.c`. The function `main` is visible, with a breakpoint set at line 120. The code includes configuration for the RTC and initialization of the BMXLXX sensor.
- Disassembly:** The right pane shows the assembly code corresponding to the selected line in the source code. It includes instructions like `mov $0x181494,%eax` and `call 0x180477 <puts>`.
- Registers:** The bottom pane shows the state of various registers. The `periph_GPIO_reg_i` register is expanded, showing fields like `GPIO_SWPORTA_DR`, `RSV0`, `RSV1`, and `GPIO_SWPORTA_DR (bits 24-0)`.

Additional panes include a **Variables** window at the top right, a **Serial Terminal** at the bottom left, and a **Microcontroller Registers** window at the bottom right.

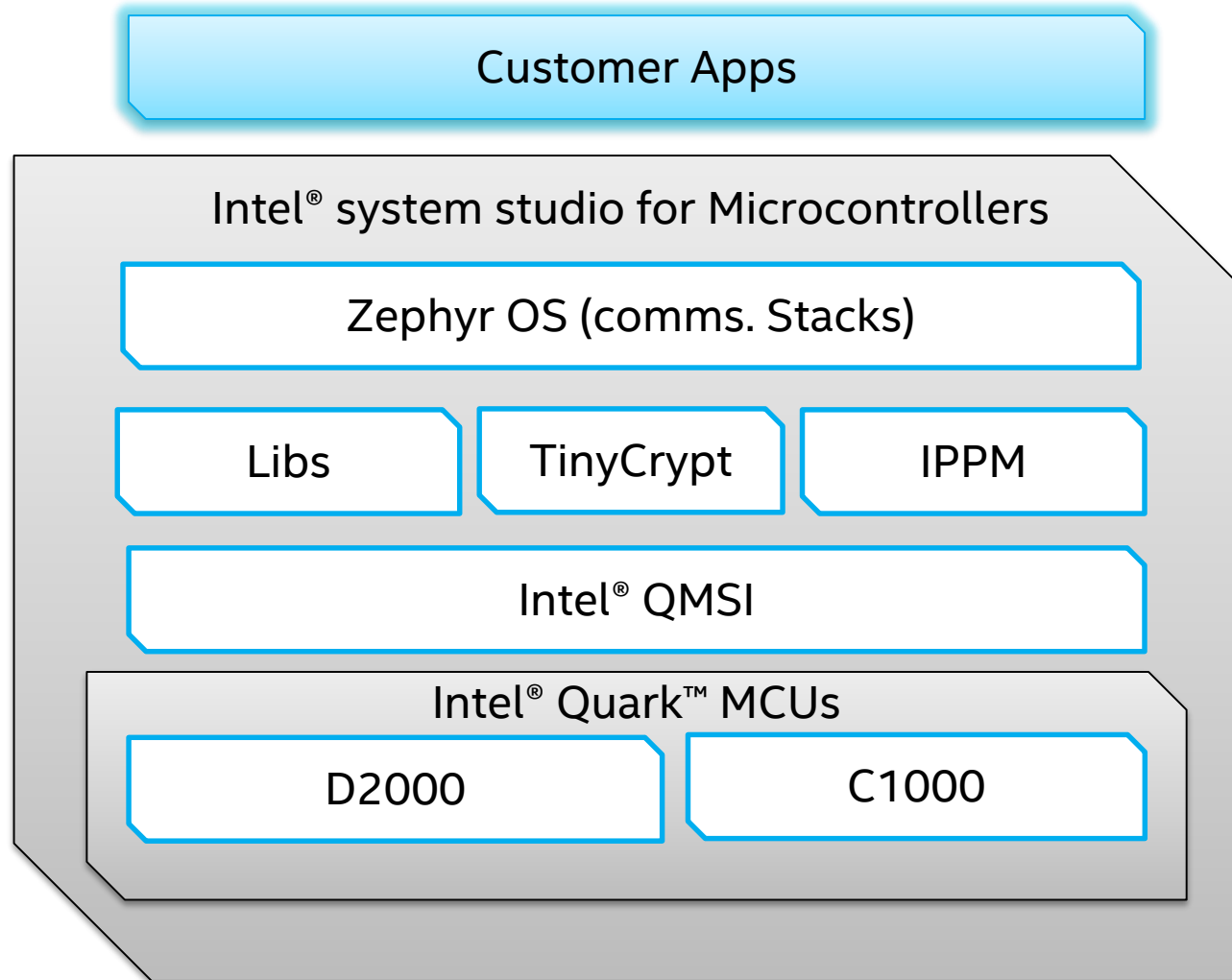
Disassembly

Code

Registers

Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.
*Other names and brands may be claimed as the property of others.

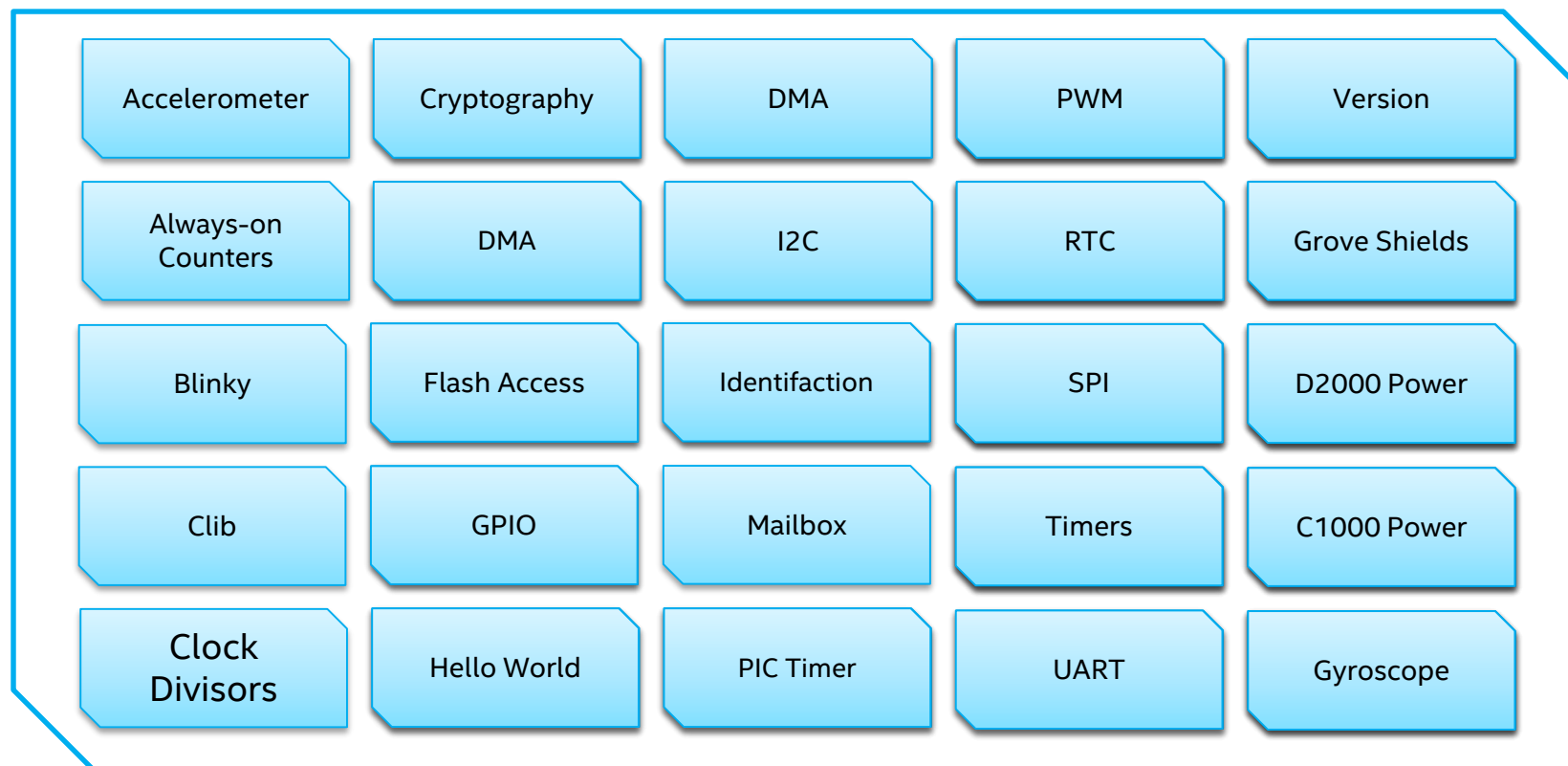


Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.

Build upon already existing example applications



Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.

Where to get Intel® QMSI™



The screenshot shows the Intel Developer Zone website. The top navigation bar is blue with the Intel logo and 'Developer Zone' text. It includes links for 'Development', 'Tools', and 'Resources', a 'Join Today' button, and a 'Log in' link. A search bar with 'powered by Google' is also present. The main content area features the title 'Intel® System Studio for Microcontrollers'. On the left is a graphic of the software box. To the right, under the heading 'Tools for Intel® Quark™ Microcontroller Software Developers', is a bulleted list of features. Further right is a yellow box titled 'Intel® Quark™ microcontroller targets' containing a 'Select Target' dropdown menu, a 'Download or Sign up' button, and a 'Product Support' link.

intel® Developer Zone

Join Today > Log in

Development > Tools > Resources >

powered by Google

Intel® System Studio for Microcontrollers



Tools for Intel® Quark™ Microcontroller Software Developers

- Create exciting IoT solutions with Intel® Quark™ microcontrollers.
- Develop efficiently in an Eclipse* integrated development environment (IDE).
- Build fast, compact code with optimizing compilers and libraries.
- Ensure quality, power efficiency, and performance with debugger and analyzer.

Intel® Quark™ microcontroller targets

Select Target ▼

Download or Sign up >

Product Support >

Intel® Developer Zone: <https://software.intel.com/en-us/intel-system-studio-microcontrollers>

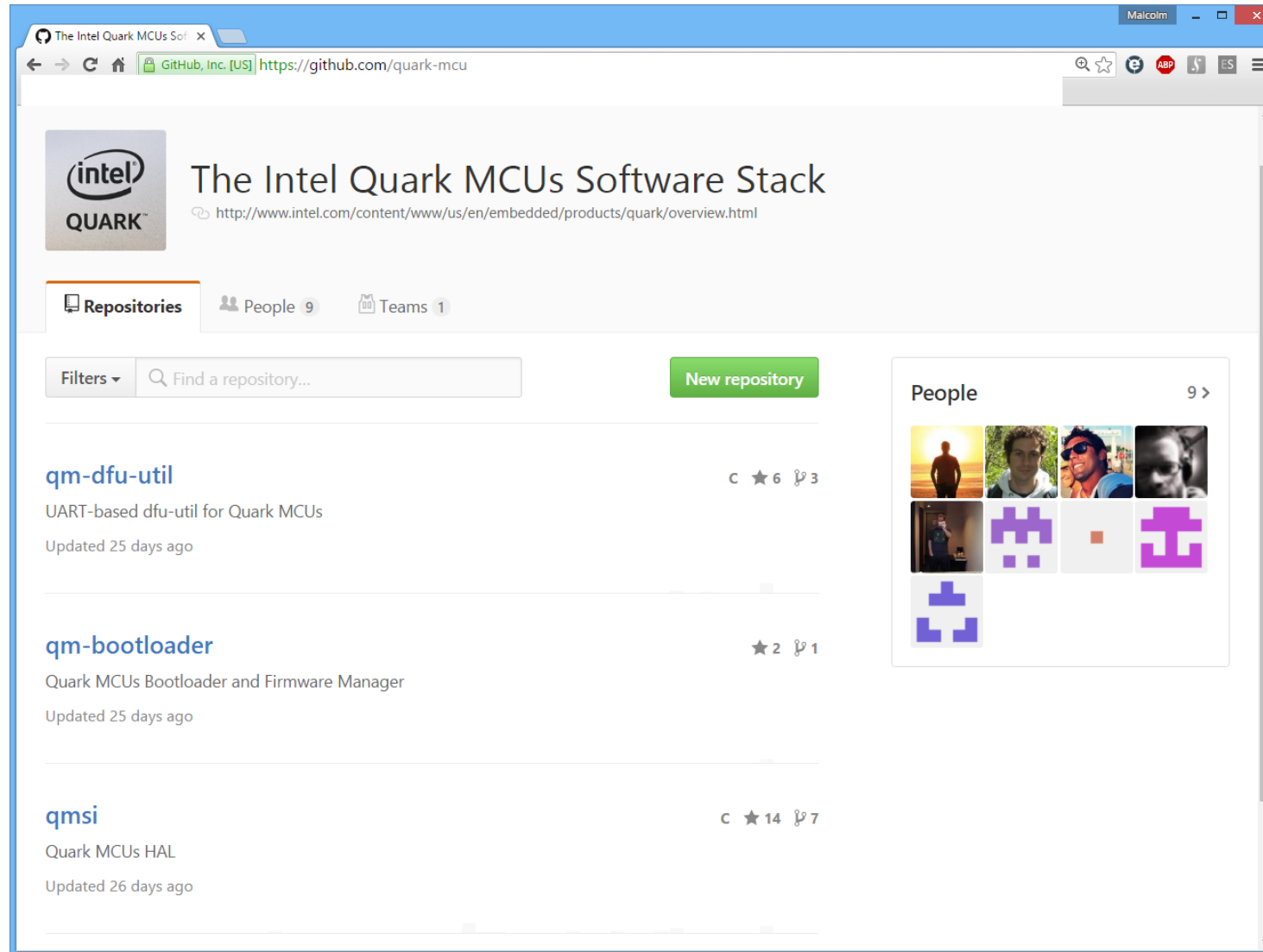
Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



Github.com/quark-mcu



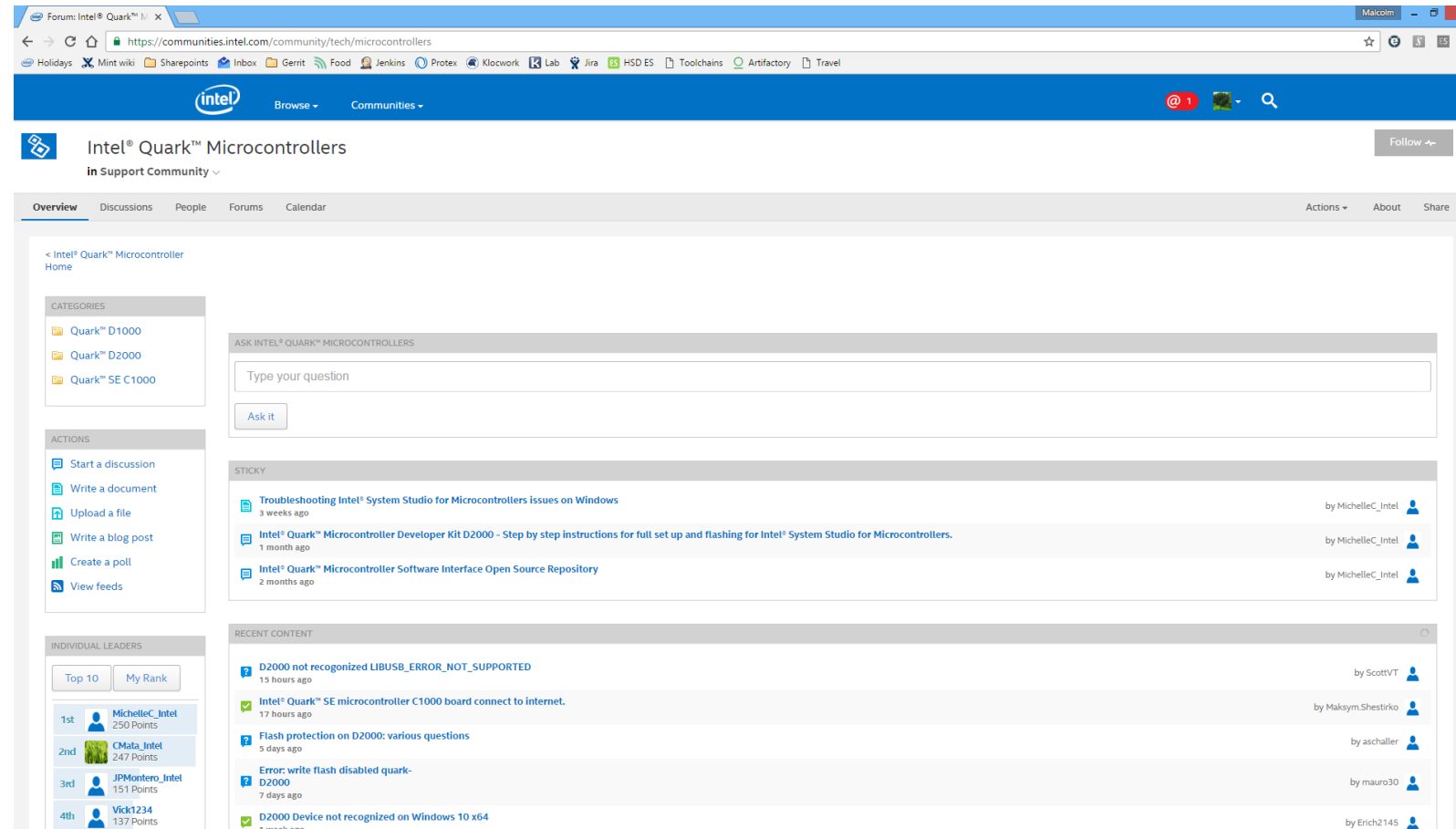
Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



Intel® Community



Intel® Quark™ Microcontroller Forum: <https://communities.intel.com/community/tech/microcontrollers>

Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



Legal Disclaimer & Optimization Notice

INFORMATION IN THIS DOCUMENT IS PROVIDED "AS IS". NO LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE, TO ANY INTELLECTUAL PROPERTY RIGHTS IS GRANTED BY THIS DOCUMENT. INTEL ASSUMES NO LIABILITY WHATSOEVER AND INTEL DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY, RELATING TO THIS INFORMATION INCLUDING LIABILITY OR WARRANTIES RELATING TO FITNESS FOR A PARTICULAR PURPOSE, MERCHANTABILITY, OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

Software and workloads used in performance tests may have been optimized for performance only on Intel microprocessors. Performance tests, such as SYSmark and MobileMark, are measured using specific computer systems, components, software, operations and functions. Any change to any of those factors may cause the results to vary. You should consult other information and performance tests to assist you in fully evaluating your contemplated purchases, including the performance of that product when combined with other products.

Copyright © 2016, Intel Corporation. All rights reserved. Intel, Pentium, Xeon, Xeon Phi, Core, VTune, Cilk, and the Intel logo are trademarks of Intel Corporation in the U.S. and other countries.

Optimization Notice

Intel's compilers may or may not optimize to the same degree for non-Intel microprocessors for optimizations that are not unique to Intel microprocessors. These optimizations include SSE2, SSE3, and SSSE3 instruction sets and other optimizations. Intel does not guarantee the availability, functionality, or effectiveness of any optimization on microprocessors not manufactured by Intel. Microprocessor-dependent optimizations in this product are intended for use with Intel microprocessors. Certain optimizations not specific to Intel microarchitecture are reserved for Intel microprocessors. Please refer to the applicable product User and Reference Guides for more information regarding the specific instruction sets covered by this notice.

Notice revision #20110804

Optimization Notice

Copyright © 2016, Intel Corporation. All rights reserved.

*Other names and brands may be claimed as the property of others.



